R-4 77-3

5230
March 1977

WESTERN SPRUCE BUDWORM
IMPACT EVALUATION

PAYETTE AND BOISE NATIONAL FORESTS
AND IDAHO DEPARTMENT OF LANDS
1976

STATE AND PRIVATE FORESTRY
Insect and Disease Control
USDA-Forest Service

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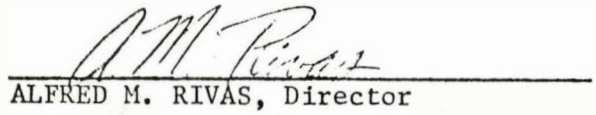
by

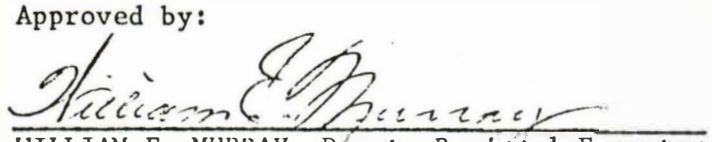
Max M. Ollieu, Ladd Livingston, and Wayne E. Bousfield

Recommended by:



ALFRED M. RIVAS, Director
Forest Insect and Disease Management

Approved by:



WILLIAM E. MURRAY, Deputy Regional Forester
State and Private Forestry

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Max M. Ollieu[1], Ladd Livingston[2], and Wayne E. Bousfield[3]

INTRODUCTION

The present outbreak of western spruce budworm, Choristoneura occidentalis, Freeman, on the Payette National Forest began in 1968 near Brundage Mountain. The infestation, which now occurs over approximately 900,000 acres of mixed conifer type, also includes portions of Boise National Forest, state, private and other federal lands. Knopf (1977) reported on the status of western spruce budworm in these areas.

Assistance was requested and received from Forest Insect and Disease Management (FIDM), R-1, Missoula, to help conduct an impact survey of affected forest stands similar to that completed by Bousfield (1975). The authors conducted the field portion of the survey in September 1976 and the data management portion was completed by FIDM, Missoula, in October 1976. Analysis of those results are reported in this evaluation.

METHODS

Three general sites were chosen for the impact study which had all experienced heavy defoliation in 1976. The first was on Brundage Mountain north of McCall which for the most part fell within the McCall Ranger District, Payette National Forest. This area had the oldest recorded infestation; approximately eight years. The second site was on State lands approximately five miles southeast of McCall. The outbreak had persisted in this area approximately six years. The third site was chosen on the Cascade Ranger District, Boise National Forest. This area has had four years of defoliation.

Using aerial resource photography, five stands from within the commercial forest component of each of the three sites were selected for sampling. They were chosen to represent as wide a range of species composition, age class and spacing as possible.

Two-man crews were employed to collect data from each stand. A compass and tape were used to establish plot centers every five chains with ten chains between cruise strips. Plot centers were common to two types of plots:

[1]Entomologist, Insect & Disease Control, Forest Service, Boise, Idaho.
[2]Forest Entomologist, Department of Lands, State of Idaho, Coeur d'Alene, Idaho.
[3]Entomologist, Forest Insect & Disease Management, Forest Service, Missoula, Montana.

(1) a variable plot which considered all trees 5 inches dbh and over and
(2) a fixed plot which accounted for all trees under 5 inches dbh.

Each variable plot represented 5 acres of the stand. A relaskop was used to select plot trees and measure their heights. A BAF of 40 was used for all stands. In addition to height, data on tree species, dbh and damage class ratings were also recorded. Damage class ratings were assigned a value from 0-6:

0 = no defoliation
1 = current year defoliation
2 = current plus older defoliation
3 = 10% or less top kill
4 = 11 to 33% top kill
5 = more than 33% top kill
6 = tree mortality by budworm

Fixed plots were used to survey numbers, species and damage class ratings of all trees under 5 inches dbh. Plots were circular and 1/300 acre in size: 6.8 feet radius.

Radial growth data were collected from two stands. Increment cores were taken from three trees nearest each plot center 5 inches dbh or larger until approximately 20 trees of three different species had been sampled. Radial growth measurements were recorded for the period of most recent defoliation and a corresponding measurement for previous years of normal growth. A binocular scope was used to measure each core. Covariance analysis was used to adjust radial growth means and enable comparisons of the three tree species.

RESULTS

Data from the impact evaluation are presented in tables 1-8. Variable plot data are contained in tables 1-4, which display volume and trees per acre 5 inches dbh and greater by species and damage class. Fixed plot data are presented in tables 5-8, which display trees per acre less than 5 inches dbh by species and damage class.

Variable plots

Data from the 14 stands show average volume to be 23,741 bd. ft. and 207 trees per acre (Table 1). Top kill occurred in 34 percent of the 5 inch dbh and greater trees. Mortality attributed to defoliation by budworm was recorded in only .07 percent of the trees.

Grand fir constituted over half of the volume and number of trees in the stands. Grand fir also displayed the most injury with 53 percent top kill in the 5 inch dbh and greater category and 1.1 percent dead (Figure 1). No mortality attributed to defoliation by budworm occurred in any other trees species. Subalpine fir also showed top killing but this species was only a minor component of the stands sampled. A minor amount of top kill was also recorded for Douglas-fir and Engelmann spruce. Western larch, lodgepole and ponderosa pine showed no defoliation, top killing or mortality from western spruce budworm.

The five stands sampled on the McCall Ranger District, Payette National Forest were in the area where defoliation commenced eight years prior. Strangely, those stands had the least percent of top killed trees: 27 percent in the 5 inches and greater category (Table 2). The State of Idaho lands with trees defoliated 6 years had 30 percent top kill (Table 3). The stands on the Cascade Ranger District, Boise National Forest, with only 4 years defoliation were 50 percent top killed (Table 4).

Stands sampled on the Cascade Ranger District contained the highest average volume, 31,685 bd. ft. per acre and lowest number of trees 5 inches dbh and greater: 152. Grand fir 5 inches dbh and greater comprised a larger component of the stand (69% volume, 74% trees) on the Cascade Ranger District than Payette National Forest or State of Idaho stands sampled.

Fixed plots

Data from the 14 stands for trees less than 5 inches dbh show an average of 791 trees per acre with 8 percent top kill (Table 5). Grand fir composed 69 percent of the trees and also suffered the most top kill. However, Douglas-fir and spruce which made up 13 and 12 percent of the stems respectively suffered top kill proportionately as high as grand fir.

Five stands sampled on the McCall Ranger District for trees under 5 inches dbh contained 660 stems per acre with 7 percent top kill (Table 6). Grand fir, Engelmann spruce and Douglas-fir all displayed top kill. State lands contained 620 stems per acre less than 5 inches with 6 percent top killed (Table 7). Grand fir and Engelmann spruce were also top killed. The Cascade Ranger District had 1091 trees per acre less than 5 inches and 9 percent top killed (Table 8). The Cascade Ranger District stands had the highest amount of grand fir regeneration, 80 percent. Both grand fir and Douglas-fir showed top killing.

Radial Growth Measurements

Increment core extractions to measure radial growth at one stand on the McCall Ranger District showed grand fir to be growing 94 percent of normal for the last five years. The area has been defoliated for eight years. Core extractions from another stand on State of Idaho lands showed

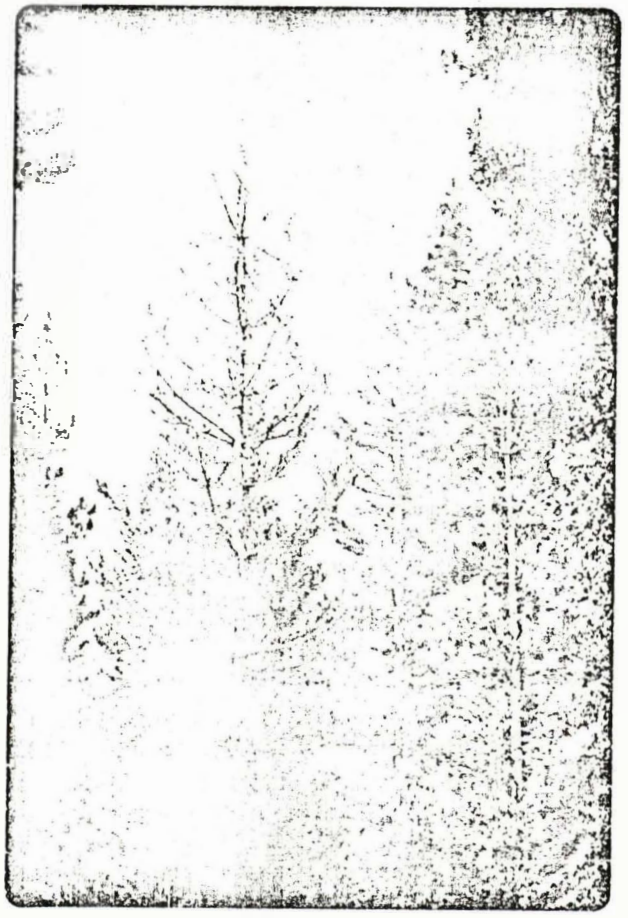

Figure 1. Grand fir top killed from defoliation by western spruce budworm, McCall R.D., Payette NF, 1976.

grand fir to be growing 74 percent of normal for the last three years. This area has been defoliated for six years. Ponderosa pine and Douglas-fir showed no radial growth reduction in either stand. Core measurements indicate growth reduction begins 2-3 years after initial defoliation.

Timber survey data from plots in the McCall area show grand fir stands produce 263 Bd.Ft./A/Yr. With average growth reduction of 16 percent in defoliated stands of grand fir then radial growth loss would equal 42 Bd.Ft./A/Yr. in the McCall area.

DISCUSSION

Stocking of conifers in the 14 stands sampled averaged 998 stems per acre with 207 trees 5 inches dbh and greater, and 791 under 5 inches dbh. These data indicate that stands are adequately stocked to overstocked. Top killing has occurred in 34 percent of trees 5 inches dbh and greater: 29 percent grand fir, 2 percent Engelmann spruce, 2 percent subalpine fir and 1 percent Douglas-fir. Top killing of trees under 5 inches dbh has occurred in 8 percent of the trees: 6 percent grand fir, 1 percent Douglas-fir and 1 percent Engelmann spruce. Mortality has been insignificant with less than 0.1 percent of trees 5 inches dbh and above killed by budworm feeding. Radial growth loss has only been recorded in grand fir with an average 16 percent slowdown in growth or 42 Bd.Ft./A/Yr. radial growth loss.

Top killing was severe in grand fir sapling and pole-sized trees particularly where a grand fir overstory was present. Deformation, multi-tops, and infection by decay fungi in this top killed grand fir regeneration will continue to impact commercial volume produced over the rotation of the stand. Removal of overstory, particularly grand fir, and thinning of top killed trees will help keep growth loss from budworm feeding to as low a level as possible.

Cascade Ranger District stands displayed the most damage from budworm feeding. They contain the highest percentage of grand fir trees, 79, the most stems per acre, 1,243, highest volume, 31,685 Bd.Ft./A, and have been defoliated the least number of years, four, when compared to the other two areas sampled. These figures apparently would also support decisions to reduce grand fir overstory and percent of the species in the stand.

Knopf (1977) predicted defoliation by western spruce budworm to continue in 1977 similar to that experienced in 1976. If that prediction holds true, the infestation area will probably expand and damage intensify. Top killing will increase, radial growth in grand fir will slow somewhat more and tree mortality will become more apparent. Additional grand fir will become unsuitable as future crop trees and cone crops of susceptible species will be poor or nonexistent.

RECOMMENDATIONS

1. Land managers with stands defoliated by western spruce budworm should examine resource values involved and determine if changes in management may be necessary.

2. Silvicultural techniques which can reduce damage by budworm include: (1) removal of grand fir overstory, (2) shortening rotation, (3) diversifying composition to favor non-host species and (4) removal of top killed regeneration.

3. Payette and Boise Forest personnel should complete section III of the Environmental Impact Statement as outlined in the Regional Forester's letter of October 22, 1976.

4. Land managers should cooperate with personnel from Insect and Disease Control and Forest Insect Research on pilot projects and field experiments of promising insecticides.

5. Insect and Disease Control personnel should conduct an aerial detection survey, parasite survey, egg mass survey and expanded stand impact survey in 1977 to provide land managers with pertinent information on budworm activity.

REFERENCES

Bousfield, W. E., P. W. Underwood, and R. C. Lood. 1975. Western Spruce Budworm Impact Evaluation, Yoosa Creek, Clearwater National Forest, Idaho, 1974. Forest Service, Forest Environmental Protection, Missoula, Montana 9 pp.

Knopf, J. A. E., A. Valcarce, and R. Beveridge. 1977. Western Spruce Budworm Biological Evaluation, Payette and Boise National Forests, 1976. Forest Service, Insect and Disease Control, Boise, Idaho. Rpt. R-4 77-2, 10 pp.

Table 1. Average volume, trees per acre and percent of each by species and damage class, for trees = > 5 inches dbh, 14 stands, Payette and Boise National Forests and State of Idaho lands, western spruce budworm impact survey, 1976.

SPECIES	TOTAL VOLUME		DAMAGE CLASSES (0) NOT DEFOLIATED				(1) CURRENT YEARS DEFOLIATION				(2) CURRENT & OLDER DEFOLIATION				(3) TOP KILL <10%				(4) TOP KILL 11-33%				(5) TOP KILL >33%				(6) MORTALITY				TOTAL TREES	
	Vol.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	No.	%
ARCH	859	3.8	804	3.8																									9.5	4.6
					9.5	4.6																										
ODEPOLE PINE	535	2.5	505	2.5																									8.2	3.96
					8.2	3.9																										
NDEROSA PINE	1525	7.3	1525	7.3																									9.07	4.82
					9.07	4.8																										
OUGLAS-FIR	3034	14.7	362	1.52			1110	4.7			1620	6.8			392	1.7													25.5	12.9
					2.2	1.1			9.3	4.5			12.1	5.9			2.9	1.4														
RAND FIR	13273	56.0	249	1.1			1036	4.4			7819	32.9			3739	15.8			332	1.4			87	0.37			11	0.05			10.99	21.0
					0.89	4.4			7.4	3.6			43.8	21.2			50.4	24.7			7.97	3.8			0.39	0.2			0.14	0.07		
UBALPINE FIR	367	1.5					50	0.21			60	0.25			211	0.8			37	0.16											9.93	4.8
									2.6	1.3			3.4	1.6			3.7	1.8			0.25	0.11										
DELMAN RUCE	3403	14.3	79	0.33			1361	5.7			1663	7.0			300	1.26															31.9	15.4
					2.3	1.1			14.8	7.2			11.2	5.4			3.5	1.7														
TOTALS: Vol.	23741	100	3904	16.6			3687	15.0			11171	46.99			4642	19.7			369	1.56			87	0.37			11	0.05			205.9	100
%					33.12	16.0			34.1	16.6			70.5	34.1			60.5	29.6			8.2	3.9			0.39	0.19			0.14	0.0		
No. Trees																																

Table 2. Average volume, trees per acre and percent of each by species and damage class, for trees = > 5 inches dbh, 5 stands, McCall R.D., Payette National Forest, western spruce budworm impact survey, 1976.

SPECIES	TOTAL VOLUME		DAMAGE CLASSES (0) NOT DEFOLIATED				(1) CURRENT YEARS DEFOLIATION				(2) CURRENT & OLDER DEFOLIATION				(3) TOP KILL <10%				(4) TOP KILL 11-33%				(5) TOP KILL >33%				(6) MORTALITY				TOTAL TREES	
	Vol.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	No.	%
SCH	1153	4.6	1153	4.6	11.96	4.3																									11.96	4.3
OGEPOLE PINE	460	1.8	460	1.8	2.9	1.1																									2.9	1.1
NTERPSA PINE	2268	9.0	2268	9.0	9.1	3.3																									9.1	3.3
UGLAS-FIR	5482	21.6	968	3.8	3.0	1.1	2660	10.5	16.4	6.0	1694	6.7	18.1	6.6	162	.6	4.9	1.8													22.4	8.5
ND FIR	10417	41.1					1696	6.7	16.8	6.1	6431	25.4	52.4	19.0	1598	6.3	48.6	17.7	540	2.1	6.1	2.2	152	.6	.62	.2					174.5	66.2
ALPINE FIR	914	3.6					151	.6	7.8	2.8	122	.5	1.2	.4	530	2.1	6.1	2.2	111	.4	.7	.3									15.9	5.7
HEMAN RUCE	4537	18.4	237	1.1	6.9	2.5	2486	9.8	38.5	14.0	1532	6.1	15.0	5.5	342	1.4	8.1	2.9													62.5	23.9
TALS: Vol. % No. Trees %	25283	100	5086	20.3	33.9	12.3	6983	27.6	79.5	28.9	9779	38.7	86.7	31.5	2632	10.4	67.7	24.6	651	2.5	6.8	2.5	152	.6	.62	.2					275.2	100

Table 3. Average volume, trees per acre and percent of each by species and damage class, for trees = > 5 inches dbh, 4 stands, State of Idaho lands, western spruce budworm impact survey, 1976.

	TOTAL VOLUME		DAMAGE CLASSES (0) NOT DEFOLIATED				(1) CURRENT YEARS DEFOLIATION				(2) CURRENT & OLDER DEFOLIATION				(3) TOP KILL <10%				(4) TOP KILL 11-33%				(5) TOP KILL >33%				(6) MORTALITY				TOTAL TREES	
SPECIES	Vol.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	No.	%
[illegible] SPRUCE	373	2.6	373	2.6																												
					8.5	3.6																									8.5	3.6
[illegible] DOUGLAS FIR	752	5.3	752	5.3																												
					10.2	5.5																									10.2	5.5
PONDEROSA PINE	721	5.1	721	5.1																												
					13	9.7																									13.0	9.7
[illegible] DOUGLAS-FIR	2197	14.2	119	0.83			457	3.2			1489	10.4			42	0.29																
					3.6	1.9			11.9	6.2			11.8	6.4			1.0	0.5													27.9	19.0
[illegible] FIR	7451	52.5	480	3.4			603	4.2			4099	28.7			1705	11.9			455	3.19			109	0.76								
					0.7	0.4			2.6	1.4			41.8	22.6			34.8	18.7			13.98	7.6			.55	0.3					98.5	51.5
WHITEBARK PINE	137	0.9									63	.4			74	0.52																
													1.4	0.76			4.3	2.3													5.7	3.1
[illegible] SPRUCE	[illegible]	19.					737	5.1			1830	12.9			148	1.0																
									5.1	2.8			13.95	7.5			1.3	0.7													20.4	11.0
TOTALS: Vol.	14245	100	2445	17.2			1797	12.5			7490	52.4			1969	13.7			455	3.19			109	0.76								
%					41.9	22.1			19.2	10.4			68.95	37.3			41.4	22.3			13.99	7.6			.55	0.3					[illegible]	100
No. Trees																																

Table 4. Average volume, trees per acre and percent of each by species and damage class, for trees = > 5 inches dbh, 5 stands, Cascade R.D., Boise National Forest, western spruce budworm impact survey, 1976.

	TOTAL VOLUME		DAMAGE CLASSES (0) NOT DEFOLIATED				(1) CURRENT YEARS DEFOLIATION				(2) CURRENT & OLDER DEFOLIATION				(3) TOP KILL <10%				(4) TOP KILL 11-33%				(5) TOP KILL >33%				(6) MORTALITY				TOTAL TREES	
SPECIES	Vol.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	Vol.	%	No.	%	No.	%
[illegible]	1157	3.65	1157	3.65	8.12	5.34																									8.12	5.34
[illegible] PINE	572	1.81	572	1.81	11.6	7.63																									11.6	7.63
[illegible] PINE	2188	6.91	2188	6.91	2.82	1.86																									2.82	1.86
[illegible]-FIR	2864	9.05					214	.68	.12	.08	1678	5.3	6.26	4.12	972	3.07	2.84	1.87													9.22	6.07
[illegible] FIR	21961	69.3	267	.84	.16	.11	818	2.58	2.6	1.84	12928	40.8	37.22	24.49	7915	24.98	67.64	44.51	0	0	3.84	2.53					33	.10	.42	.28	112.08	73.75
[illegible] FIR	52	.16									23	.07	.9	.59	29	.09	.74	.49													1.64	1.08
[illegible] [illegible]	2890	9.12					860	2.71	.76	.50	1619	5.11	4.52	297	411	1.3	1.22	.8													6.5	4.28
TALS: Vol. %	31655	100	4184	13.21			1892	5.97			16248	51.28			9327	29.44			0	0							33	.10			151.9	100
No. Trees %					22.7	14.94			3.68	2.42			48.9	32.18			72.44	47.66			3.84	2.53							.42	.28		

Table 5. Average trees per acre and percent by species and damage class, for trees < 5 inches dbh, 14 stands, Payette and Boise National Forests and State of Idaho lands, western spruce budworm impact survey, 1976.

SPECIES	DAMAGE CLASSES														TOTAL TREES	
	(0) NOT DEFOLIATED		(1) CURRENT YEAR DEFOLIATION		(2) CURRENT & OLDER DEFOLIATION		(3) TOP KILL <10%		(4) TOP KILL 11-33%		(5) TOP KILL >33%		(6) MORTALITY			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
LARCH	9.0	1.14													9.0	1.14
LODGEPOLE PINE	27.2	3.4													27.2	3.4
PONDEROSA PINE	8.9	1.13													8.9	1.13
DOUGLAS-FIR	28.3	3.6	42.7	5.4	28.3	3.6	4.0	0.5	1.0	0.1	1.0	0.1			105.3	13.3
GRAND fir	201.3	2.5	178.4	22.8	114.7	14.5	40.5	5.12	5.3	0.7	3.0	0.4			543.2	69.0
SUBALPINE FIR			2.0	0.25						0.2					2.0	0.25
ENGELMANN SPRUCE	26.8	3.4	46.4	5.9	14.5	1.8	3.0	0.4	2.5	0.3	1.7	0.2			94.9	12.0
TOTALS NO. TREES	301.5		269.5		157.5		47.5		8.8		5.7				790.5	
%		38.2		34.4		19.9		6.02		1.3		0.7				100

Table 6. Average trees per acre and percent by species and damage class, for trees < 5 inches dbh, 5 stands, McCall R.D., Payette National Forest, western spruce budworm impact survey, 1976.

SPECIES	DAMAGE CLASSES														TOTAL TREES	
	(0) NOT DEFOLIATED		(1) CURRENT YEAR DEFOLIATION		(2) CURRENT & OLDER DEFOLIATION		(3) TOP KILL <10%		(4) TOP KILL 11-33%		(5) TOP KILL >33%		(6) MORTALITY			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
LARCH	3.0	0.5													3.0	0.5
LODGEPOLE PINE	6.0	0.9													6.0	0.9
PONDEROSA PINE	21	3.2													21.0	3.2
DOUGLAS-FIR	9.0	1.4	54.0	8.2	12.0	1.8	9.0	1.4							84.0	12.8
GRAND fir	153.0	23.2	108.0	16.4	129.0	19.6	24.0	3.6	3.0	0.5					417.0	63.3
SUBALPINE FIR			6.0	0.9											6.0	0.9
ENGELMANN SPRUCE	24.0	3.6	78.0	11.8	9.0	1.4	9.0	1.4	3.0	0.5					123.0	18.7
TOTALS NO. TREES	216		246		150		42.0		6.0						660.0	
%		32.8		37.3		22.8		6.4		0.9						100

Table 7. Average volume, trees per acre and percent of each by species and damage class, for trees < 5 inches dbh, 4 stands, State of Idaho lands, western spruce budworm impact survey, 1976.

SPECIES	DAMAGE CLASSES														TOTAL TREES	
	(0) NOT DEFOLIATED		(1) CURRENT YEAR DEFOLIATION		(2) CURRENT & OLDER DEFOLIATION		(3) TOP KILL ≤10%		(4) TOP KILL 11-33%		(5) TOP KILL >33%		(6) MORTALITY			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
LARCH	15.0	2.4													15.0	2.4
LODGEPOLE PINE	48.5	7.8													48.5	7.8
PONDEROSA PINE	5.8	0.9													5.8	0.9
DOUGLAS-FIR	73.0	11.8	31.98	5.2	54.8	8.8									159.8	25.8
GRAND fir	119.4	19.7	67.9	10.96	127.2	20.5	27.7	4.5							342.2	55.7
SUBALPINE FIR																
ENGELMANN SPRUCE	26.5	4.3	8.8	1.4	4.4	0.7			4,4	0.7	4.4	0.7			48.5	7.8
TOTALS NO. TREES	288.2		108.7		186.4		27.7		4.4		4.4				619.8	
%		46.9		17.6		30.0		4.5		0.7		0.7				100

Table 8. Average volume, trees per acre and percent of each by species and damage class, for trees < 5 inches dbh, 5 stands, Cascade R.D., Boise National Forest, western spruce budworm impact survey, 1976.

SPECIES	DAMAGE CLASSES														TOTAL TREES	
	(0) NOT DEFOLIATED		(1) CURRENT YEAR DEFOLIATION		(2) CURRENT & OLDER DEFOLIATION		(3) TOP KILL <10%		(4) TOP KILL 11-33%		(5) TOP KILL >33%		(6) MORTALITY			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
LARCH	9.0	0.8													9.0	0.8
LODGEPOLE PINE	27.0	2.5													27.0	2.5
PONDEROSA PINE																
DOUGLAS-FIR	3.0	0.3		3.9	18.0	1.7	3.0	0.3	3.0	0.3	3.0	0.3			72.0	6.8
GRAND fir	331.5	30.4	359.3	32.9	87.8	8.1	69.8	6.4	12.8	1.2	9.0	0.8			870.2	79.8
SUBALPINE FIR																
ENGELMANN SPRUCE	30.0	2.8	52.5	4.8	30.0	2.8									112.5	10.4
TOTALS NO. TREES	400.5		453.8		135.8		72.8		15.8		12.0				1090.7	
%		36.8		41.6		12.6		6.7		1.5		1.1				100